NASA's Space Launch System: Developing the World's Most Powerful Solid Booster

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Abstract

NASA's Journey to Mars has begun. Indicative of that challenge, this will be a multi-decadal effort requiring the development of technology, operational capability, and experience. The first steps are under way with more than 15 years of continuous human operations aboard the International Space Station (ISS) and development of commercial cargo and crew transportation capabilities. NASA is making progress on the transportation required for deep space exploration – the Orion crew spacecraft and the Space Launch System (SLS) heavy-lift rocket that will launch Orion and large components such as in-space stages, habitat modules, landers, and other hardware necessary for deep-space operations. SLS is a key enabling capability and is designed to evolve with mission requirements. The initial configuration of SLS – Block 1 – will be capable of launching more than 70 metric tons (t) of payload into low Earth orbit, greater mass than any other launch vehicle in existence. By enhancing the propulsion elements and larger payload fairings, future SLS variants will launch 130 t into space, an unprecedented capability that simplifies hardware design and in-space operations, reduces travel times, and enhances the odds of mission success. SLS will be powered by four liquid fuel RS-25 engines and two solid propellant five-segment boosters, both based on space shuttle technologies. This paper will focus on development of the booster, which will provide more than 75 percent of total vehicle thrust at liftoff. Each booster is more than 17 stories tall, 3.6 meters (m) in diameter and weighs 725,000 kilograms (kg). While the SLS booster appears similar to the shuttle booster, it incorporates several changes. The additional propellant segment provides additional booster performance. Parachutes and other hardware associated with recovery operations have been deleted and the booster designated as expendable for affordability reasons. The new motor incorporates new avionics, new propellant grain, asbestos-free case insulation, a redesigned nozzle, streamlined manufacturing processes, and new inspection techniques. New materials and processes provide improved performance, safety, and affordability but also have led to challenges for the government/industry development team. The team completed its first full-size qualification motor test firing in early 2015. The second is scheduled for mid-2016. This paper will discuss booster accomplishments to date, as well as challenges and milestones ahead.